INHERITANCE AND LINKAGE RELATIONS OF TWO NEW ENDOSPERM TYPES IN DENT CORN

BY

WALTER JOHN MUMM

B. S., University of Illinois, 1919

M. S., University of Illinois, 1928

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRONOMY IN THE GRADUATE SCHOOL OF THE UNIVERSITY OF ILLINOIS, 1940

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INHERITANCE AND LINKAGE RELATIONS OF TWO NEW ENDOSPERM TYPES IN DENT CORN

Seed characters of maize have always interested geneticists because of their wide variety and ease of classification, together with the fact that crosses are easily made and large populations can be produced on a single ear under a uniform environment. A very large number of genes affecting the seed have been described, their mode of inheritance determined and their linkage relations established. Pericarp color, aleurone color, endosperm texture and color and other qualities of the scutellum and embryo have been the subject of many investigations already reported in the literature dealing with the genetics of maize.

The two new endosperm characters reported in this investigation produce soft starch and were first found by the author while engaged in a study of the relation of endosperm texture to disease resistance of corn seedlings. The first gene (*h*) was found in 1927 in some breeding material that Dr. C. M. Woodworth had inbred for nine generations for another purpose. Except for the one starchy ear that was found in this progeny, all the ears were horny. It is presumed that a mutation must have occurred at least two generations before it was noticed, because one segregating generation must have intervened in order that all the kernels on an ear could show the character at the time it was discovered. The new gene was designated by the symbol *h* because it was recessive to horny, designated as *H*. It is completely recessive in the F_1, and segregates in a ratio of 3 horny: 1 starchy in the F_2. It produces an endosperm with a soft interior and cap, surrounded by a thin, corneous band. Classification in well matured ears is not difficult.

The second gene, (fl_2) that produced soft starch in the endosperm was found in 1929, in another inbred line. This line had previously bred true for horny endosperm. One ear was found that was segregating for endosperm texture. It produced 96 horny seeds and 93 very soft seeds, very nearly a 1:1 ratio. Further studies in succeeding generations confirmed this ratio.

In the first generation of crosses with horny corn, *fl*$_2$ behaved as though it was maternally inherited. When a starchy plant was pollinated with horny pollen, the progeny remained starchy; when a horny plant was pollinated with starchy pollen, the progeny remained horny. Crosses with flour corn indicated that the starchiness was due to a new gene with similar breeding behavior. On this account, the new gene was called floury 2 and designated by the symbol *fl*$_2$. It became necessary to refer to the original floury gene as floury 1 and to designate it as *fl*$_1$. The gene *fl*$_2$ produces a very soft endosperm that is easily distinguished on segregating ears when they are fully mature. The seeds are as soft as those produced by the gene *fl*$_1$ and are softer than those produced by the gene *h*, though starchy seeds on segregating ears when both *h* and *fl*$_2$ are involved cannot be separated for the two characters with any degree of certainty.

When *h* was crossed with *fl*$_1$, the F_1 was horny when the ear parent was h h, and starchy when the ear parent was *fl*$_1$ *fl*$_1$. In the first instance, the pollen parent (*fl*$_1$ *fl*$_1$ *HH*) brought in the gene H which was dominant over *h*, and produced a horny endosperm. In the second instance, while the pollen parent (*h h Fl*$_1$ *Fl*$_1$) brought in the gene *Fl*$_1$ the seeds were still starchy because they had the composition *fl*$_1$ *fl*$_1$ *Fl*$_1$. In the second generation, the seeds segregated in a ratio of 3 horny: 5 starchy.

When h was crossed with waxy (*wx*) the F_1 was horny regardless of which way the cross was made. In the F_2, a ratio of 9 horny: 3 starchy: 4 waxy was obtained.

When h was crossed with sugary (*su*$_1$) the F_1 was horny regardless of which way the cross was made. In the F_2, a ratio of 9 horny: 3 starchy: 4 sugary was obtained.

The crosses with waxy and sugary indicate that h is hypostatic to su_1 and wx.

The results of crosses between *fl*$_2$ and *fl*$_1$ have already been mentioned. The first cross was starchy regardless of which strain was used as the ear parent. Floury 1 (*fl*$_1$ *fl*$_1$ *Fl*$_2$ *Fl*$_2$) brought in *Fl*$_2$ when it was used as the pollen parent and floury 2 (*Fl*$_1$ *Fl*$_1$ *fl*$_2$ *fl*$_2$) brought in *Fl*$_1$ when it was used as the pollen parent but *fl*$_1$ *fl*$_1$ *Fl*$_1$ and *fl*$_2$ *fl*$_2$ *Fl*$_2$ are both starchy. The

F2 segregated in a ratio of 1 horny: 3 starchy, which would be the expected ratio if they are independent of each other. In a cross between fl_2 and su_1 with the sugary type as the ear parent, the F_1 seeds were all horny. In the F_2, a ratio of 3 horny; 3 starchy: 2 sugary was obtained. This would be the expected ratio if the two genes are independent and if fl_2 is hypostatic to su_1. No cross was made with waxy.

Linkage tests indicated that *h* was independent of floury 1 (fl_1) in Group 2, sugary (su_1) in Group 4, yellow (Y) in Group 6, virescent (V_5) and glossy (gl_1) in Group 7, and waxy (*wx*) in Group 9. No crosses were made with any genes in Groups 1, 5, 8 and 10. Linkage was indicated with d_1 in Group 3 with 25% of crossing over. It can therefore be assumed that *h* is on Chromosome III.

Linkage tests indicated that fl_2 was independent of floury 1 (fl_1) in Group 2, sugary (su_1) in Group 4, yellow (Y) in Group 6. japonica (*j*) in Group 8 and lineate (*li*) in Group 10. No crosses were made with any genes in Groups 1, 5, 7 and 9.

When fl_2 was crossed with *h* (Group 3), the F2 ratio was very near 1 horny: 3 starchy (26% horny: 74% starchy) instead of a ratio of 3 horny: 5 starchy, which would be expected if the two genes were independent. The ratio that was obtained would be possible if it is assumed that fl_2 and *h* are closely linked, with 4% of crossing over.

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VITA

The writer was born on a farm near Sidney, Illinois, November 20, 1895. His early education was received in the rural school of that vicinity. In 1913 he was graduated from Sidney High School at the head of his class. In 1914 he graduated from Urbana High School where he took additional work necessary to meet the entrance requirements of the University of Illinois. In the fall of 1915 he entered the College of Agriculture at the University of Illinois.

In the spring of 1918, he enlisted in the Coast Artillery Corps of the United States Army. In July, 1918, he entered the Officers' Training School at Fort Monroe, Virginia, and was commissioned as a Second Lieutenant in September. He served until his discharge in the Coast Defenses of Boston Harbor with the 61st Ammunition Train and the 28th Regiment, C. A. C. After his discharge, he returned to the University of Illinois. He received his Bachelor of Science degree at the end of Summer School, 1919.

From 1921 to 1926, he was engaged in farming on the home farm at Sidney. In February, 1927, he again entered the University of Illinois to do graduate work in the Department of Agronomy, specializing in Plant Breeding. In September, 1927, he was appointed assistant in the Department of Agronomy and the Experiment Station. In June, 1928, he received the degree of Master of Science in Agronomy. In March, 1929, he was appointed Instructor in the Division of Plant Breeding and First Assistant in the Experiment Station. In September, 1931, he was appointed Associate in Plant Breeding and in the Experiment Station, serving in this capacity until February, 1938, when he resigned to become Hybrid Corn Specialist with Crow's Hybrid Corn Company at Milford, Illinois.

The writer is affiliated with Phi Sigma, Alpha Zeta, Gamma Sigma Delta and Sigma Xi.